VISIT…

SECTION 14

GROMMETS, SPACERS & INSERTS

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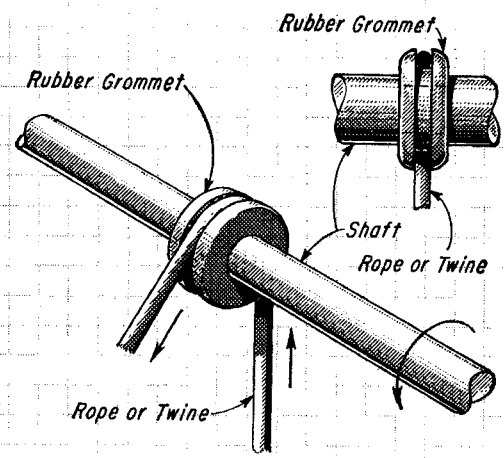
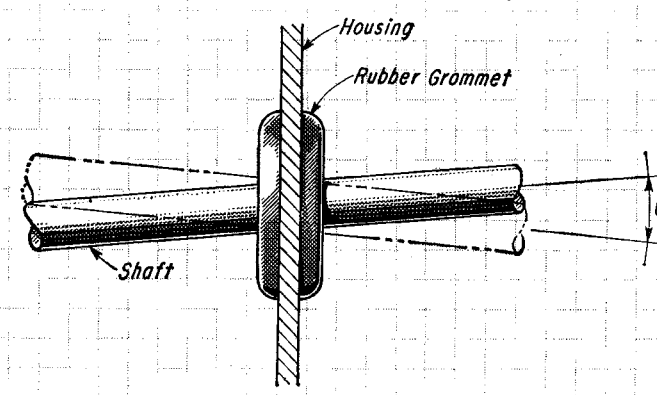
A Fresh Look at Rubber Grommets

A small component that's often neglected in the details of a design. Here are eight unusual applications.

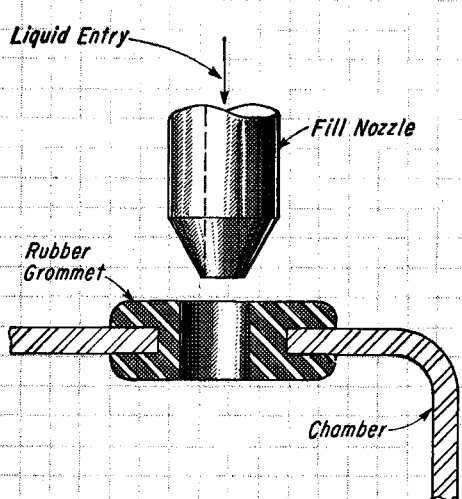
Robert O. Parmley



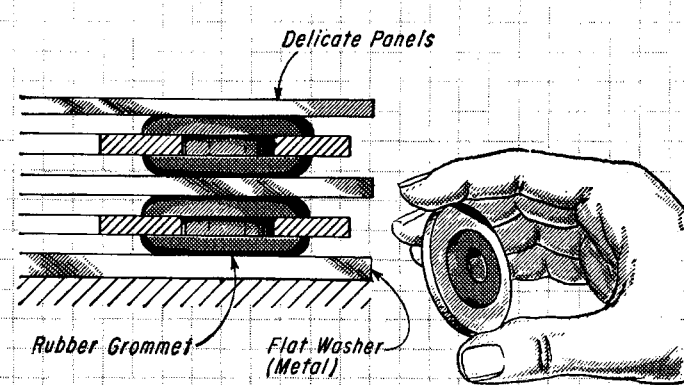
1 Pulley for slow rotation



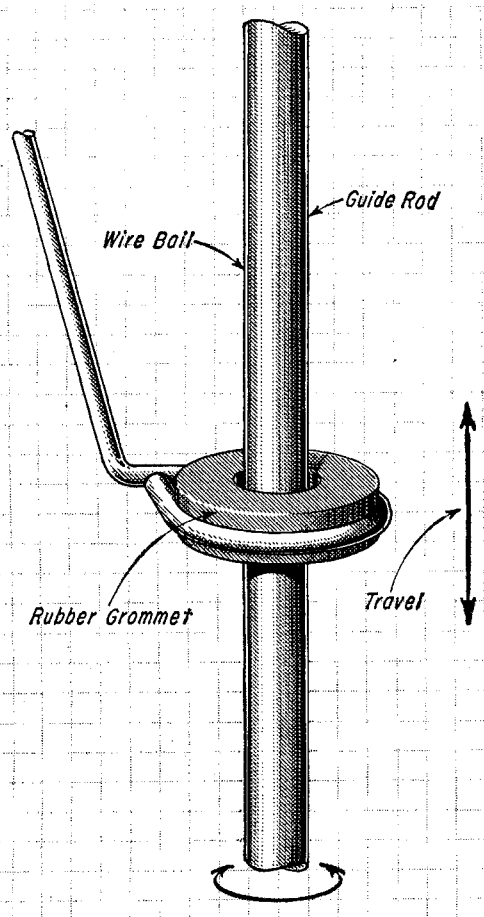
2 Handle shaft misalignment



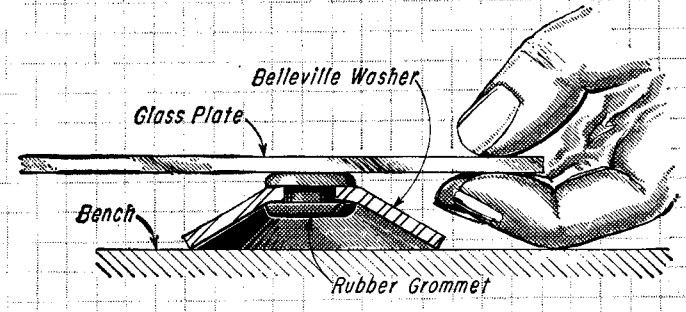
5 Seal for liquid filling



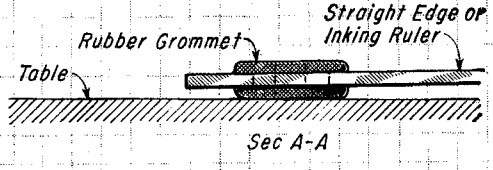
6 Cushioned spacers

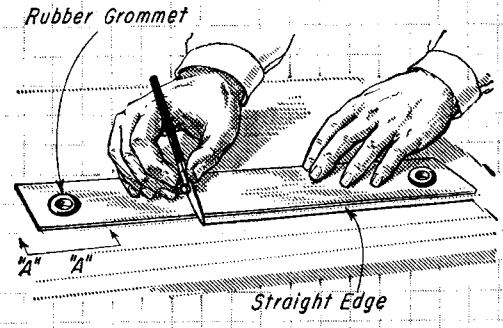


3 Guide liner

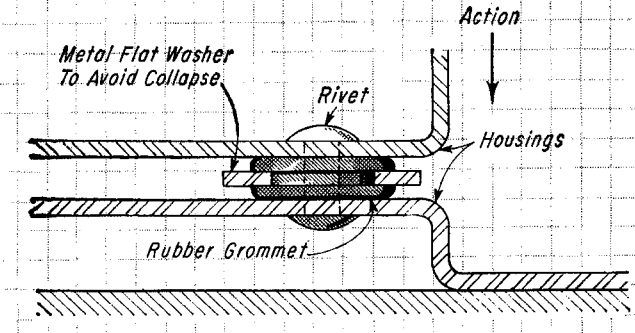


4 Support delicate work plates





7 Straightedge pads

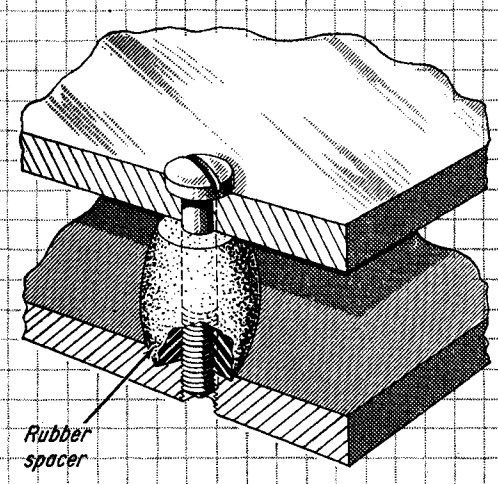


8 Shock absorber

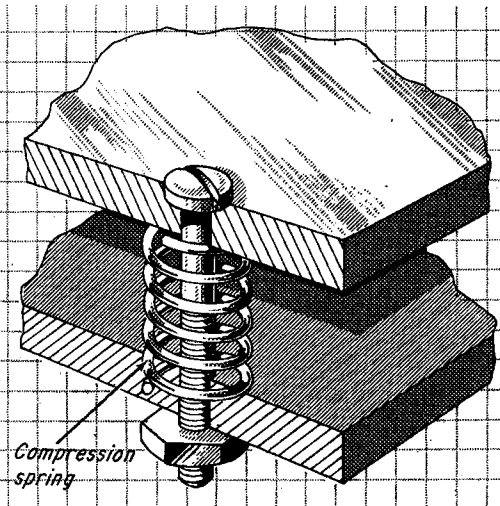
These Spacers are Adjustable

Rubber, metal springs, jackscrews, pivoting bars and sliding wedges allow adjustment after assembly.

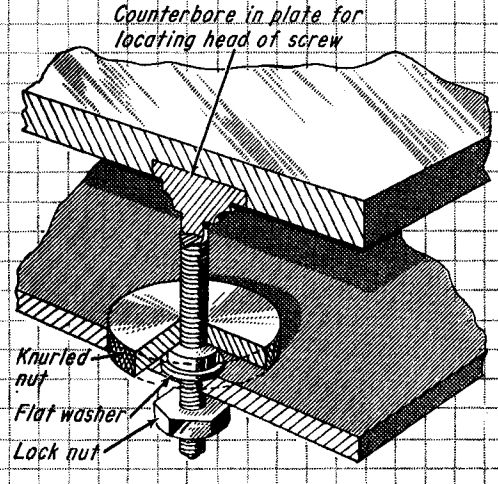
Richard A. Cooper



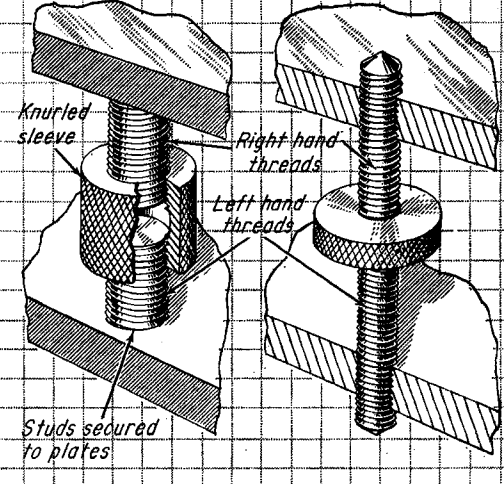
1 **TUBULAR RUBBER SPACER** is low-cost, efficient device for space adjustment and shock absorption.



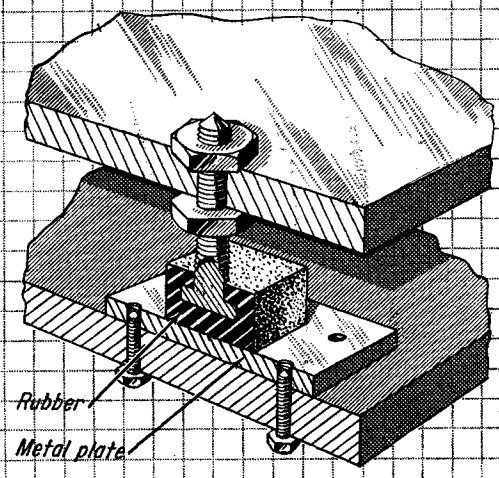
2 **COMPRESSION SPRING** should be close fit on the adjustment bolt to avoid side deflection of the spring.



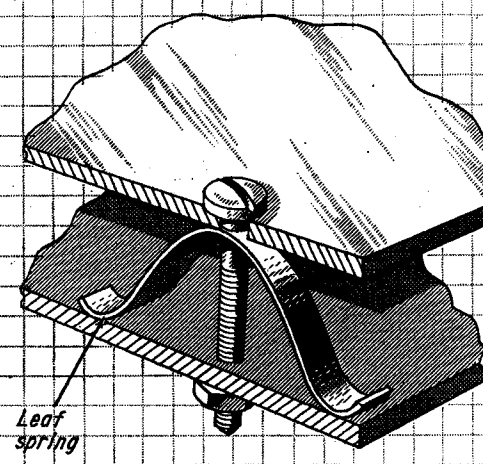
5 **JACKSCREW** and knurled nut assure accurate adjustment. Here the top piece floats for easy removal.



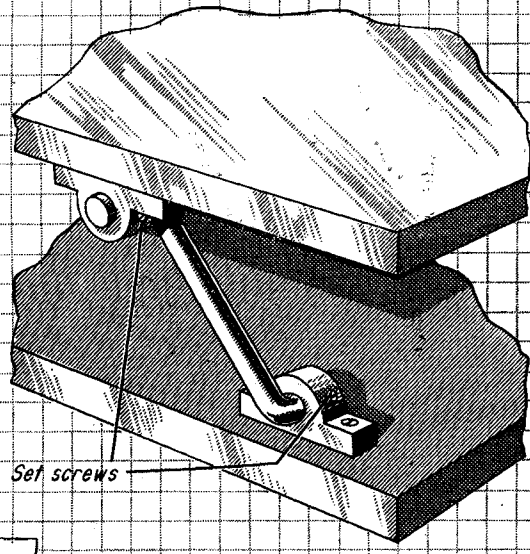
6 **OPPOSITE-THREADED STUD** device for moving both parts exactly the same distance with one adjustment.



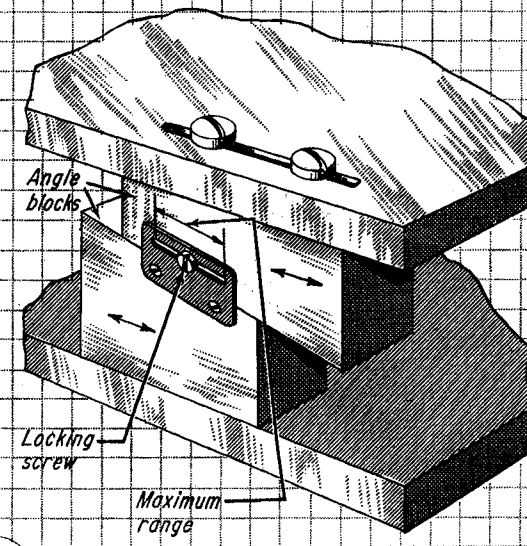
3 **RUBBER-SUPPORTED STUD** is attached to the metal plate. Support heavy loads with this assembly.



4 **LEAF SPRING** ends should be turned up to prevent their digging into the bottom part, which could prevent adjustment.



7 **PIVOTING BAR** allows wide range of adjustment where torque at clamping points is low enough to allow a tight hold.

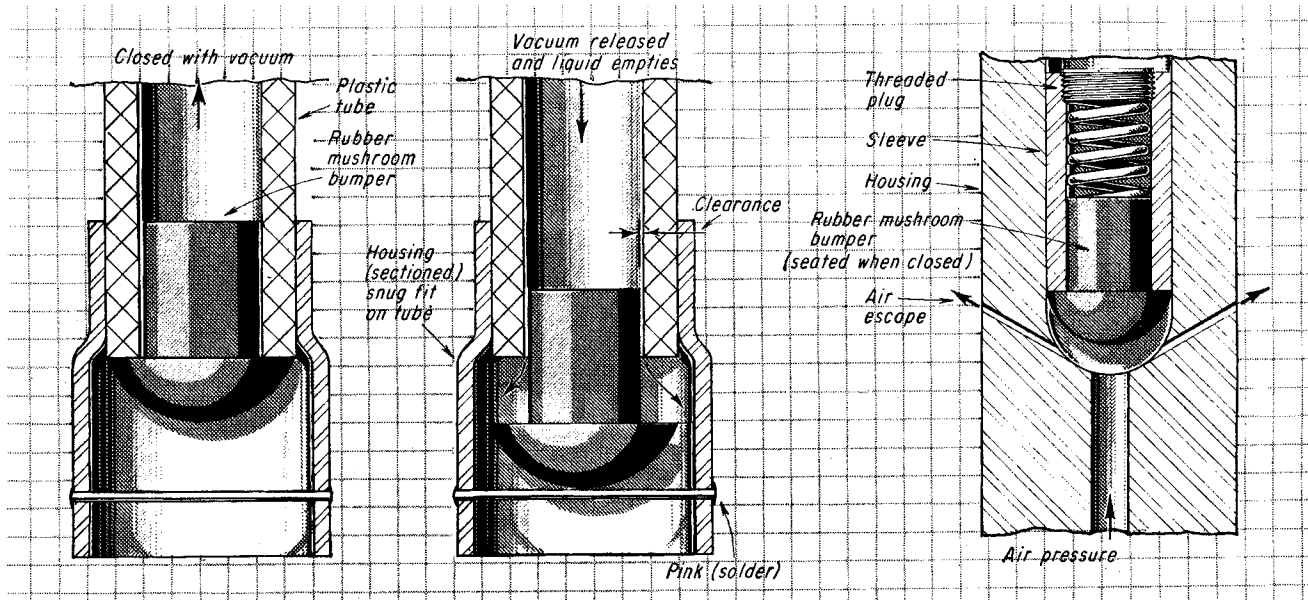


8 **SLIDING ANGLE BLOCKS** permit great accuracy in simultaneous lateral and vertical adjustment of parts.

Odd Jobs for Rubber Mushroom Bumpers

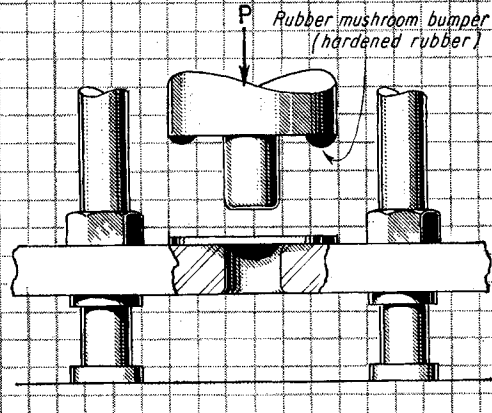
High energy absorption at low cost is the way mushroom bumpers are usually billed. But they have other uses; here are seven that are rather unconventional.

Robert O. Parmley

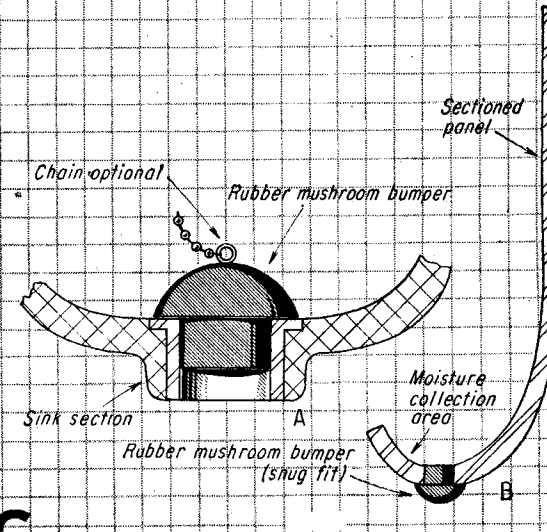


1 Discharge valve for tubing

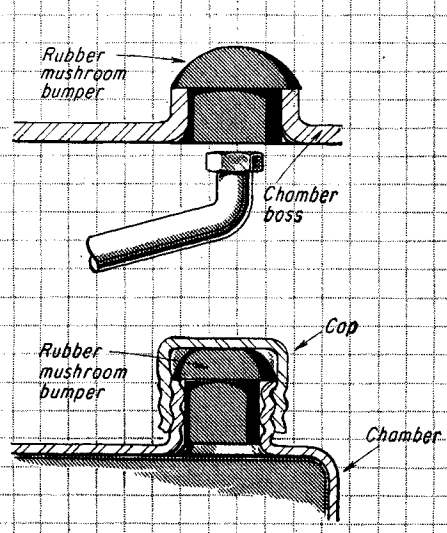
2 Air pressure valve



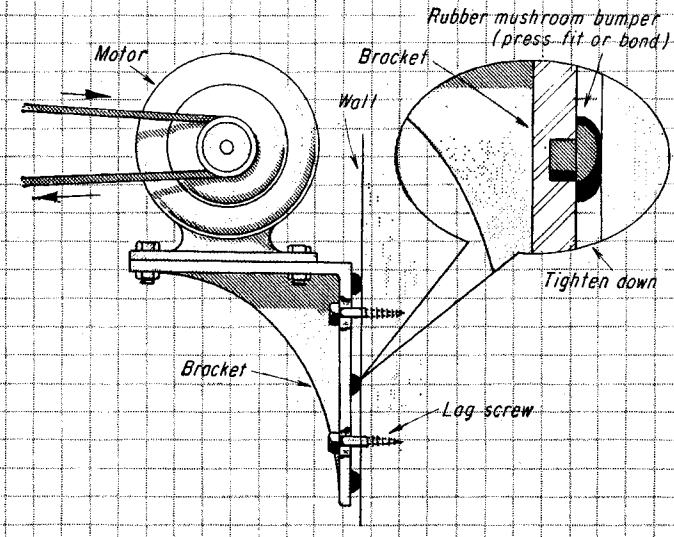
5 Punching protector



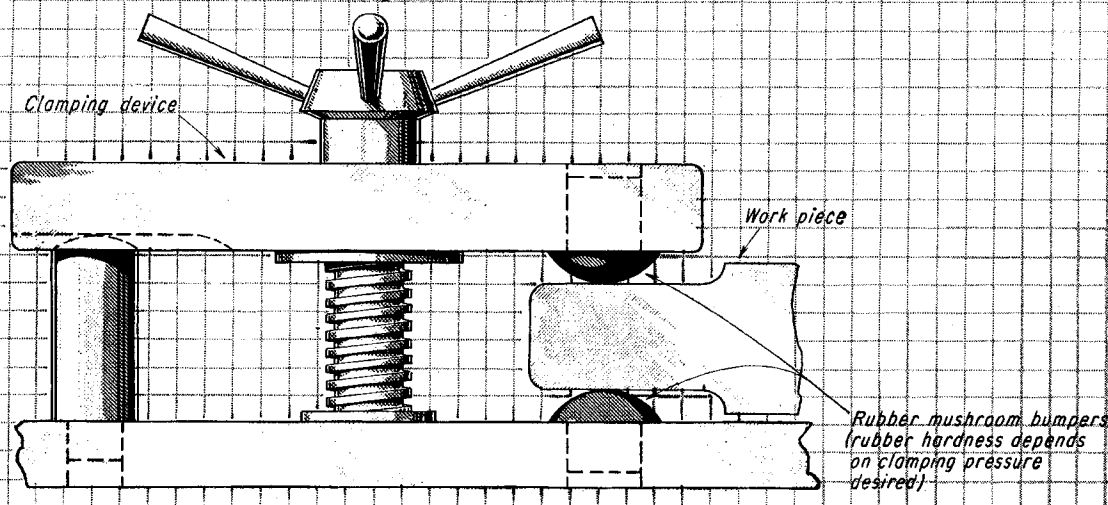
6 Drain plugs



3 Chamber plug



4 Cushion motor vibration



7 Clamp delicate parts

Metal Inserts for Plastic Parts

Plastics are increasingly used in automobiles and appliances and thus a major company compiled these data.

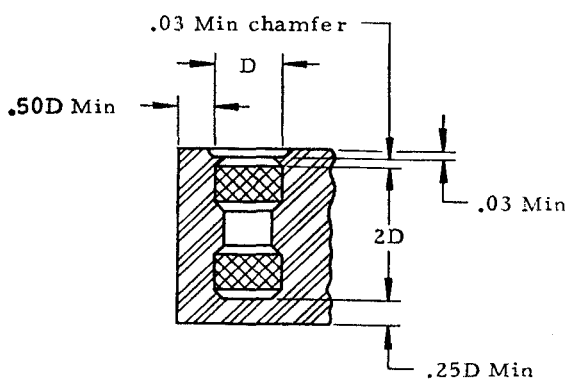
Molded parts should be designed around any inserts that are required. This work is done after the type of compound is selected. Inserts are used for two basic reasons:

1. To add strength to the plastic part or to control shrinkage. Sometimes the purpose is to be decorative or to avoid injuries.
2. To provide an attachment means for the conductance of heat or electricity.

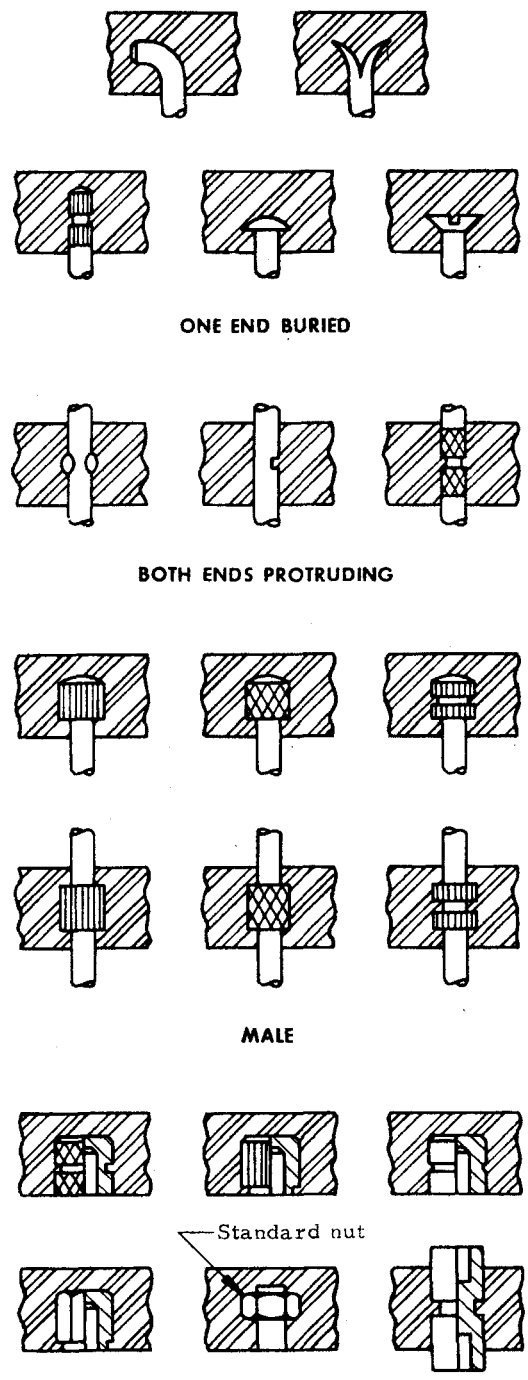
Special means of retention are not necessary for inserts not subject to movement with relation to the molding material. Inserts of round bar stock, coarse diamond knurled and grooved, provide the strongest anchorage under torque and tension. A large single groove, as in Fig. 1, is better than two or more grooves and smaller knurled areas.

Inserts secured by press or shrink fits

Inserts can be secured in the plastic by a press fit or shrink fit. Both methods rely upon shrinkage of the plastic, which is greatest immediately after removal from the mold. The part should be made so that the required tightness is obtained after the plastic has cooled and shrinkage has occurred. The amount of interference required depends on the size, rigidity and stresses to be encountered in service. The hole to receive the mating part should be round and countersunk. In addition, the mating part should be chamfered and filleted to facilitate proper assembly and to eliminate stress concentration.



1. Depth of knurling should be about 0.001 in. and a single groove is best



2. Round knurled parts are common inserts

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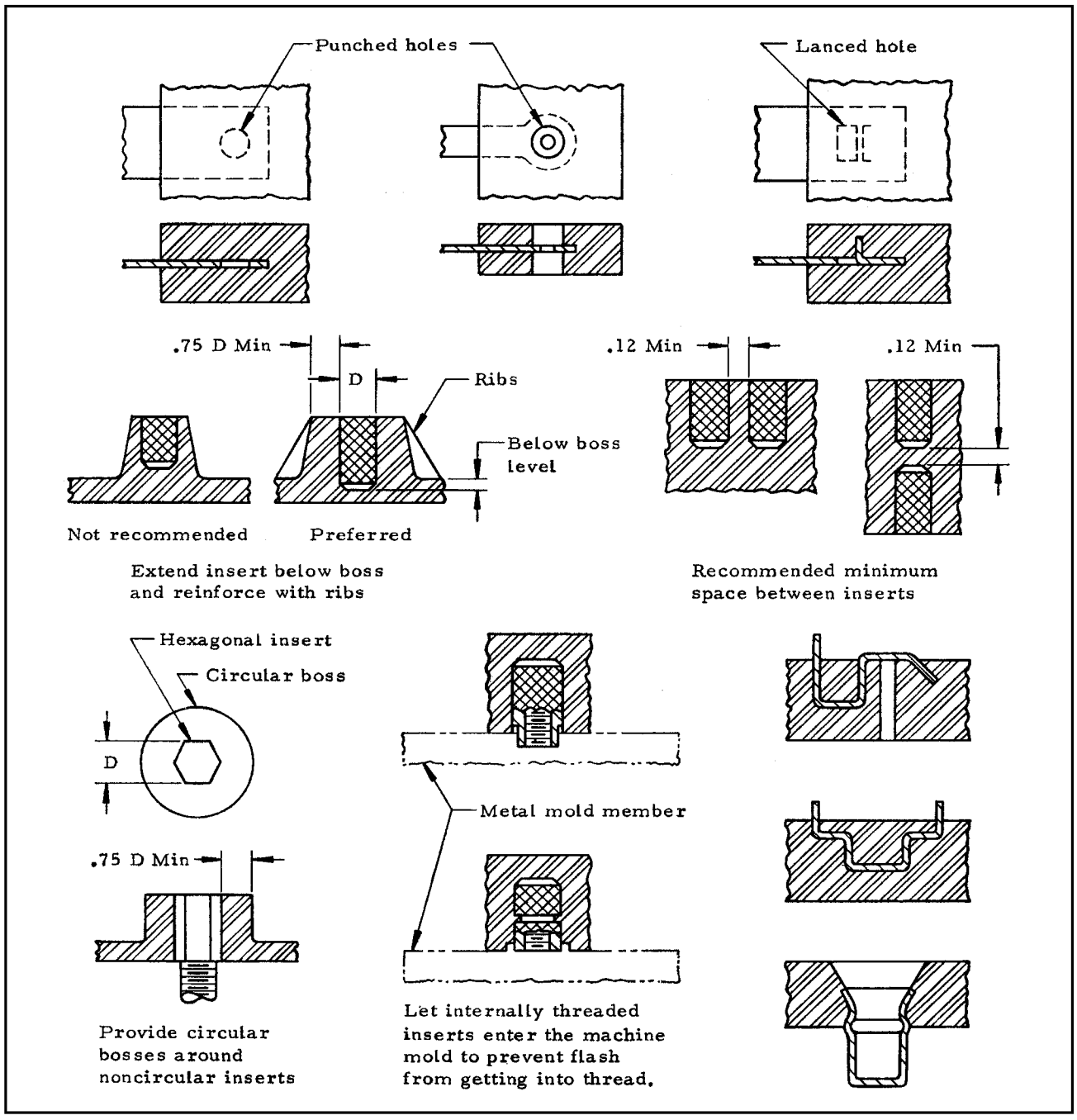


3. Sheet metal and special inserts, as well as knurled inserts, are used to provide connections and closures

How to Select Threaded Inserts

Why use threaded inserts? What types are available? What factors govern their selection? How do you determine whether a particular insert meets the given strength requirements and which one is most economical?

S. H. Davison

When the design calls for lightweight materials like aluminum, magnesium and plastics, threaded holes become a problem because of the low shear strength of these materials. To bolt such components to other machine parts, the threaded holes must be quite deep to develop the required pull-out strength, or they must have a coarse thread to increase shear area.

Further complications arise when the components require frequent disassembly for overhaul or repair; this may give excessive thread wear that will prevent satisfactory thread engagement with the bolt, particularly for high-strength bolts in the fine-thread series; and the depth of engagement needed will require a part so thick as to nullify the lightweight advantage of the material. To overcome these problems, thread inserts of high-strength material are often used.

Inserts available

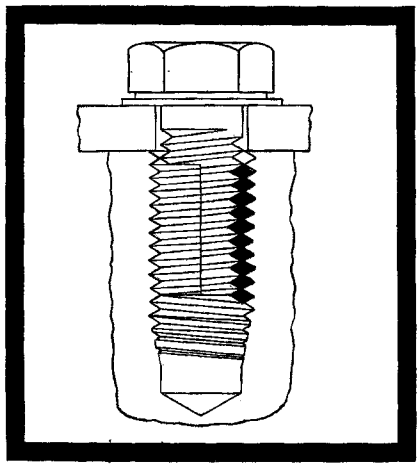
Three main types of inserts are available:

1. Wire thread inserts are precision coils of diamond-shape stainless steel wire. They line a tapped hole and present a strong, accurate, standard internal thread for the bolt or stud. The OD on these inserts is from 11 to 30% greater than the OD of the internal thread—the lower limit is normally used on the fine-thread inserts specified in aircraft engines. The pull-out strength of wire thread insert depends on shear area of its OD thread.

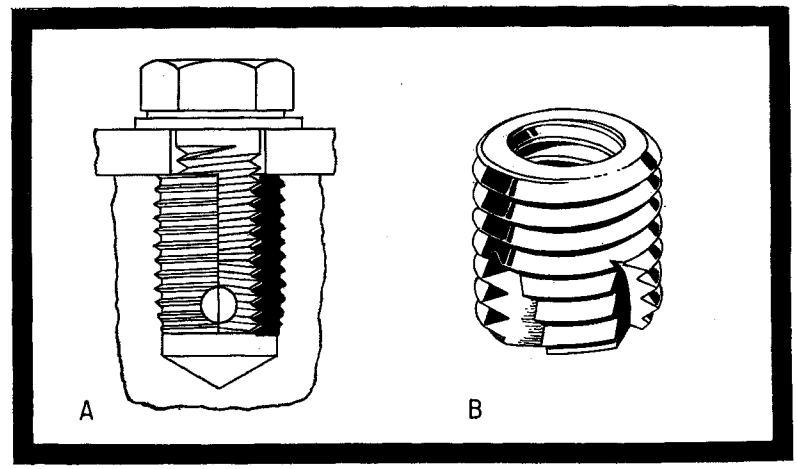
2. Solid self-tapping inserts require only a drilled hole and counterbore in the part, and are made in two basic forms. (1) A solid self-tapping, self-locking bushing has a 60% external thread approximating the American National form with a uniform OD extending to the first 2 to 2½ threads. These leading threads are slightly truncated to provide the cutting action necessary for self-tapping. Chips flow out through the side hole drilled in the insert wall at the truncated lead threads. (2) A second type has lead threads similar to the pilot threads of a standard tap. These threads progressively flow into truncated threads extending the entire length of the insert—with the exception of the last three threads, which are standard.

In both types, two or three angular slots, depending on the particular design, provide the cutting action for self-tapping.

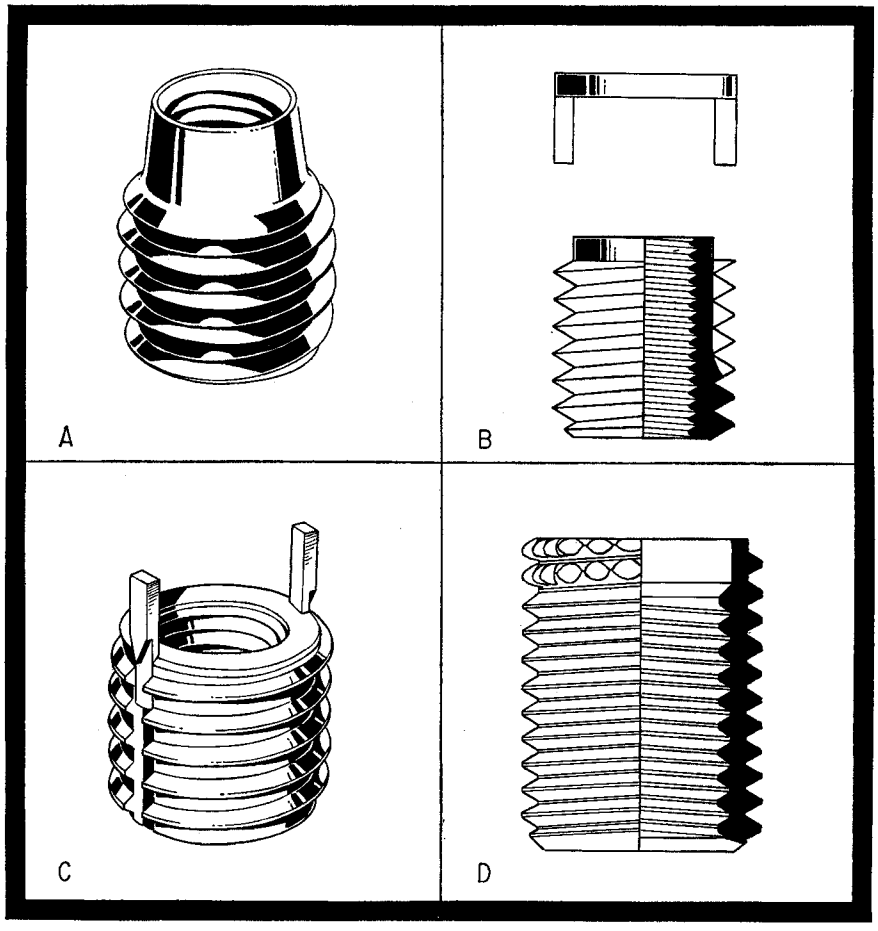
3. Solid bushings for pre-tapped holes are also made in



WIRE THREAD INSERTS made of diamond-shape stainless steel wire. Pull-out strength of material depends on ratio of internal to external thread shear area.



SOLID SELF-TAPPING INSERTS are of two types—(A) chips are removed through the side hole; or (B) with truncated lead threads and two or three angular slots which provide cutting action.



SOLID INSERTS FOR PRE-TAPPED HOLES have many variations. Among the most popular are: (A) modified external threads for interference and locking action; (B) two-piece unit with key ring for locking action; (C) integral keys give locking action; (D) expandable collar with external serrations.

two general types. The first uses modified external threads that form an interference with the parent material, and provide locking action. The second type has many variations, but is characterized by standard external and internal threads, with various types of pins or keys to lock the bushing to the parent material. Some of the most widely used variations are:

A two-piece insert with a locking ring and two keys fits into mating grooves in upper external threads. The ring is pressed into place after the insert is screwed into tapped hole; it cuts through enough threads of parent material to provide a positive lock. A counterbore in the tapped hole is required for the ring, but assembly and replacement can be made with standard tools.

Another solid bushing insert has two integral keys which act as a broaching tool when insert is installed flush with the parent material. Locking pins are pressed into the base of the tapped hole through the grooves in the external thread.

Still another, a solid bushing, has standard internal and external threads and an expandable upper collar with serrations in the outer surface to lock the insert in the parent material.

Factors that affect selection

These factors must be considered in selecting the best type:

- Shear strength of parent material
- Operating temperature
- Load requirement
- Vibratory loads
- Assembly tooling—serviceability and ease of installation
- Relative cost

Shear strength of parent material below 40,000 psi generally calls for threaded inserts. This includes most of the aluminum alloys, all magnesium alloys and plastic materials. But other factors must be considered.

High operating temperature effects the shear strength by reducing strength of the parent material; an insert with a larger shear area may be required.

Bolt loading frequently makes it necessary to use threaded inserts. For example, if the full pull-out strength of a 125,000-psi bolt is required, it is probable that the parent material will need a threaded insert to increase the shear area and thus reduce the effective shear stress.

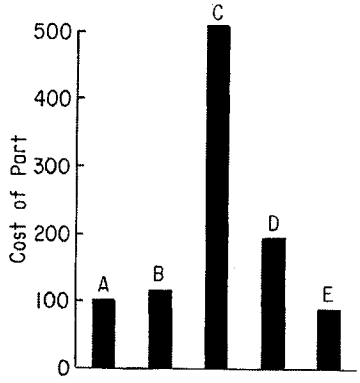
Vibratory loads may reduce bolt preload, and require a threaded insert to increase the effective shear area. Or vibration may cause creep, galling, and excessive wear, and inserts with both external and internal thread-locking features will be needed.

The pullout capacity of an insert is a function of projected shear area, and should equal the tensile strength of the bolt. This means pull-out strength should be greater than torque-applied tensile strength of the bolt.

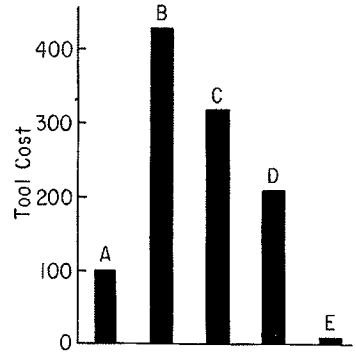
In wire thread inserts the projected shear area per coil

RELATIVE EVALUATION—5 TYPES OF THREAD INSERTS

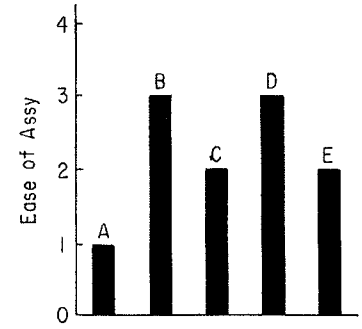
(A—self-tapping insert; B—wire thread insert; C—solid bushing for pre-tapped holes; D—solid bushings for pre-tapped holes and external interference threads; E—self-tapping insert)



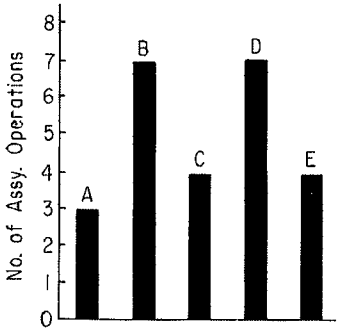
COST OF PART is price quoted for lots of 1000.



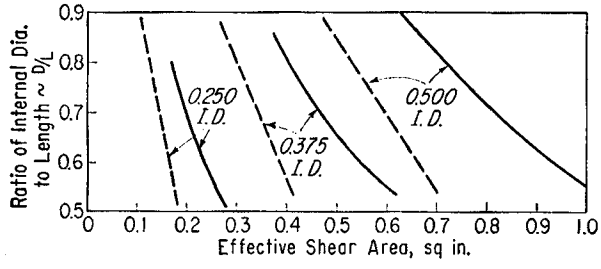
TOOL COST for each type is based on manufacturer's prices for tooling a standard tapping head.



EASE OF ASSEMBLY is a qualitative evaluation.



NUMBER OF ASSEMBLY OPERATIONS covers complete installation of an insert, including drill, counterbore, tap, ream, install and reinspect.



A USEFUL RELATION is effective shear area to *D/L* ratio. It determines required insert length or pull-out strength. Solid curves are for self-tapping inserts; dotted curves for wire thread inserts.

is relatively small; only way to increase the total projected shear area is to increase the number of coils. On the other hand, in solid and self-tapping inserts the projected shear area can be increased by a larger OD as well as by more threads, while maintaining the same bolt diameter.

One way to determine adequacy of pull-out capacity is to plot the ratio of the internal diameter vs insert length as a function of the effective shear area developed in the parent material. The accompanying curves for three sizes of self-tapping and wire thread inserts were derived from tests in which the insert was pulled out of the parent material. Similar curves could be developed to determine the length needed for any other type of insert.

For example, assume that a ¼-28 bolt with an ultimate strength of 5000 lb is to be used in a material with a shear strength of 20,000 psi. The required shear area is 5000 lb/20,000 psi = 0.25 sq in. From the accompanying curves, the *D/L* ratio is 0.57; insert length, $L = 0.25/0.57 = 0.438$ in.

Similar calculations, using the same curves, can determine whether length of the insert is sufficient to give a required amount of creep resistance: The creep strength of the parent material is substituted for shear strength in the above calculation.

Also, if the insert length is limited, these calculations will give the available pull-out strength, which will vary with shear area of the insert. This analysis can be used to determine either the required length or pull-out strength, and from this, the thickness of the parent material for minimum weight and maximum economy.

Solid threaded bushings often permit using a shorter bolt than for the wire thread insert with limited shear area. With a large number of fasteners in an assembly, weight saving in reduction of parent material is much greater than the small extra weight added by the solid insert.

Other important factors in selecting inserts are assembly tooling, serviceability, relative cost, and ease of installation. These factors have been evaluated in the bar charts prepared by W. Moskowitz of GE's Missile and Space Vehicle Dept, Philadelphia. Data are for five types using 10-32 internal threads. Part of this information is based on estimates of the operating personnel concerning the number of assembly operations, tolerances required during installation, and relative ease of installation.

Flanged Inserts Stabilize Multi-Stroke Reloading Press

E. E. Lawrence, Inventor
Robert O. Parmley, Draftsman